

SOIL SURVEY OF TOMPKINS COUNTY, NEW YORK.

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LOCATION AND BOUNDARIES OF THE AREA.

Tompkins County, N. Y., is located in the west-central part of the State, in what is known as the Finger Lake region. The county is nearly rectangular in outline, and comprises a total land surface of 315,264 acres, or about 492 square miles. It lies between the latitude $42^{\circ} 17'$ and $42^{\circ} 18'$ north, and between the meridians $76^{\circ} 15' 28''$ and

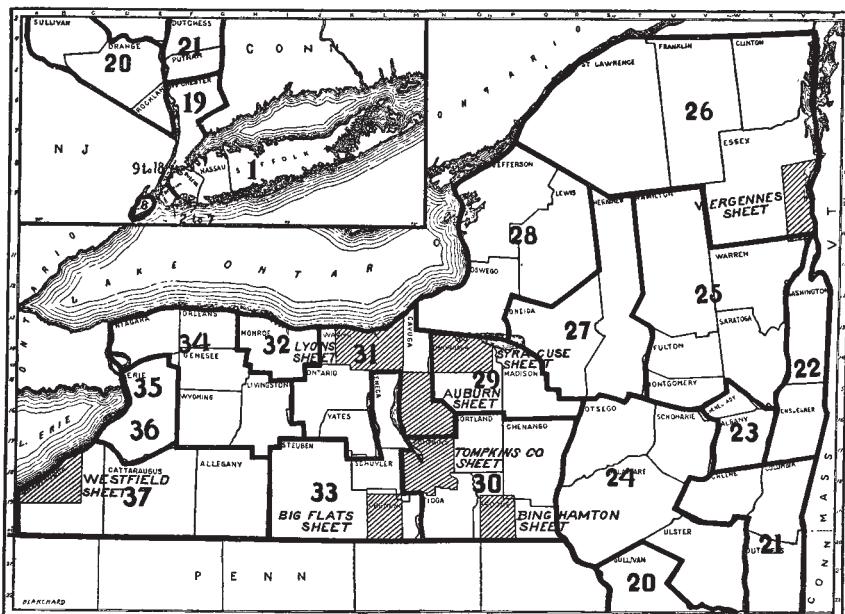


FIG. 1.—Sketch map showing location of the Tompkins County area, New York.

$76^{\circ} 41' 42''$. Cayuga Lake extends diagonally into the northwest-
ern part of the county, and at its head is situated the city of Ithaca,
with a population of about 14,000. Cornell University and the Cornell
College of Agriculture and Experiment Station are located at this
place. The other principal towns of Tompkins County are Dryden,
Groton, and Trumansburg.

HISTORY OF SETTLEMENT AND AGRICULTURAL DEVELOPMENT.

The attention of settlers was first drawn to this part of New York State through the expedition under General Sullivan in 1778-79. A portion of Sullivan's force camped near Ithaca, and upon their return the soldiers of this force carried back descriptions of the central New York region. Very few settlements were made in this part of the State before the year 1800. The lands of this section were ceded to the State of New York in 1789 by the Iroquois, and a part of the territory, known as the "military tract," was soon opened to settlement. This tract was laid out in townships of 100 lots, containing 600 acres each. All of Tompkins County, except the three southern townships, were included in this military tract.

During the colonial history of New York State, Tompkins County was a portion of Albany County. By later subdivisions it became a part of Tryon, and then of Montgomery. On April 17, 1817, Tompkins County was erected from Cayuga and Seneca counties. As then constituted, it consisted of the towns of Hector, Ulysses, and Covert from Seneca, and Dryden, Locke, and Genoa from Cayuga. In 1882 the towns of Danby, Caroline, and Cayute, now called Newfield, were annexed from Tioga County. In 1853 a part of the town of Newfield was annexed to Chemung County. In 1854 the town of Hector was made a part of Schuyler County. At the present time Tompkins County is made up of Caroline, Danby, Dryden, Enfield, Groton, Lansing, Ithaca, Newfield, and Ulysses townships.

The first white settlers in Tompkins County consisted of a group of 11 men who left Kingston, N. Y., in 1788. In 1789 three members of this group finally settled upon a lot of 400 acres located within the present site of Ithaca. At this time Tompkins County, with the exception of a few Indian fields, was heavily covered with great forest trees. The remaining townships of Tompkins County received their first settlements between 1791 and 1804. The first duty of these settlers was to cut roads through the dense forests to connect them with the earlier-settled portions of the State. The first road of this character to reach completion extended from Oxford, Chenango County, through Dryden Village, Etna, and Varna, to Ithaca. The forests of the county furnished an excellent opportunity for lumber operations, and sawmills, which were established at an early day, served the double purpose of furnishing a salable lumber product and at the same time of aiding in clearing the land for agricultural purposes. White pine constituted a considerable proportion of the upland forests, some hemlock existed and considerable hardwood, including maple, oak, beech, and chestnut. During the early stages of the development of Tompkins County corn and wheat were the crops most generally grown. Potatoes were introduced by John Yaples,

who "traveled on foot 160 miles to a point on the Delaware, where he obtained 3 pecks of potatoes—eyes or sprouts—and returned carrying them in a sack upon his shoulders." Later large quantities of hay were produced in connection with wheat and corn, and Tompkins County still remains an important hay and grain growing region.

All of the earlier settlers as soon as possible planted fruit trees, and many old orchards still survive. Within recent years grapes, peaches, pears, and similar fruits have been planted to a considerable extent, especially along the slopes from the upland down to Cayuga Lake. At the present time grass constitutes the chief crop in respect to acreage. Oats, wheat, corn, and buckwheat follow in the order named.

CLIMATE.

In general the climate of Tompkins County is that characteristic of central and western New York, although the range of temperature is somewhat less than in other parts of the region. The snowfall is also said to be lighter than in surrounding counties. The prevailing northwest air currents in winter carry the evaporation from the surface of Lake Ontario—the waters of which are very deep and seldom freeze—over the region east of Tompkins County, where it is precipitated as snow.

There is but one Weather Bureau station in Tompkins County, and this is situated at Ithaca and therefore within the local influence of Lake Cayuga. There are probably some slight differences in the conditions found here and in parts of the county more remote from the lake, but the figures given in the following table doubtless represent with fair accuracy the general characteristics of temperature and precipitation in the county at large. The figures are normals, based on records covering a long period of years.

Normal monthly and annual temperature and precipitation.

Month.	Ithaca.		Waverly.		Month.	Ithaca.		Waverly.	
	Tem- pera- ture.	Precipi- ta- tion.	Tem- pera- ture.	Precipi- ta- tion.		Tem- pera- ture.	Precipi- ta- tion.	Tem- pera- ture.	Precipi- ta- tion.
January	° F. 24.3	In. 2.00	° F. 23.6	In. 2.24	August	° F. 67.9	In. 3.43	° F. 67.4	In. 3.61
February	24.6	2.03	24.4	2.05	September	61.3	2.97	61.5	3.02
March	31.5	2.51	32.2	2.66	October	50.1	3.13	49.7	3.13
April	44.7	2.18	45.5	2.39	November	38.5	2.63	38.6	2.58
May	57.3	3.73	57.8	3.40	December	29.4	2.49	28.5	2.52
June	66.4	3.65	66.5	3.46	Year	47.1	34.57	47.2	34.94
July	70.3	3.76	70.3	3.88					

Based upon records kept at Ithaca, covering a period of twenty-five years, from 1879 to 1903, inclusive, the average date of last killing frost in spring is May 2 and of the first in fall, October 11. The

average number of days between killing frosts, or in other words the average length of the growing season for all but the winter crops, is 132 days. The following table will show the variation from these averages:

Dates of first and last killing frosts.

Year.	Ithaca.		Year.	Ithaca.	
	Last in spring.	First in fall.		Last in spring.	First in fall.
1883.....	May 14	Oct. 5	1894.....	May 29	Sept. 26
1884.....	May 29	Oct. 10	1895.....	May 22	Sept. 15
1885.....	May 12	Oct. 8	1896.....	Apr. 9	Oct. 10
1886.....	Apr. 9	Oct. 16	1897.....	Apr. 27	Oct. 18
1887.....	Apr. 25	Oct. 15	1898.....	Apr. 22	Oct. 17
1888.....	May 3	Oct. 15	1899.....	Apr. 17	Oct. 3
1889.....	Apr. 23	Oct. 16	1900.....	May 3	Oct. 20
1890.....	May 2	Sept. 25	1901.....	Apr. 1	Oct. 28
1891.....	May 6	Oct. 12	1902.....	May 10	Oct. 10
1892.....	Apr. 26	Oct. 22	1903.....	May 2	Oct. 25
1893.....	Apr. 26	Oct. 16			

PHYSIOGRAPHY AND GEOLOGY.

Tompkins County constitutes a portion of the Allegheny Plateau. Its highest elevations are found in the southern part of the county in Dryden and Caroline and Newfield townships, where the highest hills rise to 1,900 and 2,000 feet above sea level. The topography of all of the county lying south of Dryden, Ithaca, and Enfield Center is very hilly. The tops of the hills are usually only gently rolling to nearly level, but the bordering slopes to the deeply-cut stream valleys are steeper and even precipitous. North of the line mentioned the upland portion of the county is more gently rolling, but is also cut by several deep stream valleys like those of Salmon and Owasco creeks. Cayuga Lake occupies a deep gorge in the northwestern part of the county and receives the stream drainage of the greater proportion of the area. The descents to this lake on all sides are very steep, being as great as 400 feet in the mile. The surface of the lake lies at an elevation of 381 feet above tide water. The waters of Cayuga Lake flow into Lake Ontario.

The underlying consolidated rocks of Tompkins County consist of shales and sandstones of the Portage and Chemung groups. These are rather thin bedded and are easily broken up when exposed to surface weathering. The Tully limestone outcrops near lake level along both shores of Cayuga Lake. Through the shales and sandstone of the region the streams, abounding in many small water falls, have cut deep gorges, particularly in the vicinity of Cayuga Lake.

The soils of Tompkins County, while influenced by the underlying rock, are more directly traceable in their origin to the action of the

great continental glacier which swept over all of the northern part of the United States in recent geological times. This ice sheet, descending from the north, occupied the country to the depth of 2,000 feet or more. During this time the shale and sandstone rocks of the region in many instances were eroded and the surface material thoroughly ground up. With this finely ground material was deposited later a considerable amount of finely ground rock material brought in from regions of the north. The upland soils of the region are thus formed from the local material modified in varying degrees by material brought in from outside the county. At the time when the ice sheet receded many of the natural drainage outlets were dammed by the ice front and the drainage of the county was forced southward through the Sixmile Creek Valley and the Danby Valley into the Susquehanna system. While the drainage was being forced southward across these higher passes, considerable bodies of water were penned in between the ice front and the low divides across which the water flowed, forming local glacial lakes within whose waters sediments from the upland were deposited. Later, when the ice had withdrawn from the Mohawk and St. Lawrence drainage systems, the present outlets for the Tompkins County drainage were opened and the waters receded to their present position, leaving as evidence of their former existence many small upland swamps and extensive sedimentary deposits of various kinds. During the recession of the ice it halted at various places, and the debris carried within and on the ice was dumped in long, narrow ridges called "moraines."

As a result of the glaciation of Tompkins County, the material spread over the surface, which now constitutes the soils, may be divided into four groups. All of the southern and southeastern portion of the county, which was but feebly glaciated, is occupied by loam, shale, and clay soils, formed in part from the grinding up of the local rock and to a much less degree from the addition of deposited glacial material. The lower plateau soils contain a considerably higher proportion of material brought in from outside the district. Throughout both regions there are numerous morainal dumps, which give rise to stony and gravelly soils. In Dryden Valley near Dryden Lake, Freeville, Etna, Groton, and in the vicinity of McLean there is a series of glacial lake sediments consisting of higher lying materials, which are sandy and gravelly, and if lower-lying heavy loams and clays deposited in deeper water. The same is true of a considerable proportion of the valley extending from Ithaca down Sixmile Creek to the vicinity of Brookton, Slaterville Springs, and Caroline. Another series of deposits of this character occupies both sides of Cayuga Lake from water level to an elevation of about 1,000 feet. These deposits extend to about the same elevation along the sides of Salmon Creek gorge and turn westward

along the valleys of Taghanic and Trumansburg creeks, where they extend out of the county into Schuyler and Seneca counties. All of the broader stream valleys are bordered by small deposits of gravelly loam and clay of an alluvial origin. The larger deposits of this character occur between Buttermilk Valley and Cayuga Lake in the Cayuga inlet valley. Along the margin of all the large valleys there are local accumulations of shale and of upland soil which have been washed down through the action of torrential streams and spread out in low flat cones. This material is also of an origin more recent than the period of glaciation. In the northern part of Tompkins County is a single soil type, Miami stony loam, which represents to a marked degree the material brought into Tompkins County through the glacial occupation of the region. Throughout this soil type in both surface soil and subsoil is scattered a considerable quantity of limestone gravel and some limestone boulders. The fine dirt of the soil also contains finely divided lime rock. While several other soils of the region contain a large proportion of finely divided limestone, the Miami stony loam is most marked by its occurrence.

In several places in Tompkins County there are some small areas in which the covering of glacial soil is almost or entirely lacking. Where the underlying formation is sandstone the rock is usually found outcropping, but along both shores of Cayuga Lake a soft shale is found, which under the influence of frost and rain forms local areas of residual soil, only a few acres in extent and interesting chiefly for their geological significance.

SOILS.

Owing to the different methods by which the soils of Tompkins County have been formed the various types fall into certain groups which are known as soil series. In each series the proper or geographical name indicates the relationship and origin, while the descriptive name shows the texture or physical character of the type. The soils, chiefly of glacial origin, are included in the Volusia series.

The soils of the Volusia series consist of the débris of sandstone and shale, derived from the consolidated underlying material of the Upper Devonian rocks of central New York and northern Pennsylvania, mingled with varying quantities of glacial material brought in from other regions. With these soils are others derived from the glacial dumps known as "moraines." The series is marked throughout by the presence of a considerable quantity of shale and sandstone fragments, varying in size from small chips the size of a 10-cent piece to large platelike fragments a foot or more in breadth and about an inch thick. This series of soils is found throughout all of southern New York, northern Pennsylvania, and northeastern Ohio, occupying the elevated and deeply gorged Allegheny Plateau country along the southern limits of glacial action.

The Miami series, which is so extensively developed in more northern and western parts of the glacial region, is represented by only one type, Miami stony loam. This series differs from the Volusia in showing a larger percentage of limestone, gneiss, and other rocks of foreign origin brought by the ice from more northern areas.

The soils, consisting of material from the glaciated uplands, which, at the end of the glacial period, were washed down in local temporary lakes and ponds and redeposited as glacial lake or stream terraces, have been included in the Dunkirk series. As these lakes have become completely or partially drained their deposits have formed agricultural soils.

The Wabash series of dark-colored recent alluvial soils is represented by the Wabash loam.

There are some local soil formations which are also given descriptive names.

The following table gives the name and area of the several types:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Volusia loam	91,328	29.0	Dunkirk clay loam	7,552	.4
Volusia silt loam	78,912	25.1	Miami stony loam	7,488	2.3
Dunkirk stony clay	30,976	9.8	Volusia clay loam	5,952	1.9
Rough stony land	17,856	5.6	Volusia gravelly loam	4,608	1.5
Dunkirk gravelly loam	14,528	4.6	Wabash loam	4,352	1.4
Volusia stony loam	12,352	3.9	Dunkirk shale loam	4,224	1.3
Dunkirk gravelly sandy loam	12,032	3.8	Dunkirk fine sandy loam	1,600	.5
Dunkirk loam	12,032	3.8	Dunkirk silt loam	1,344	.4
Meadow	8,128	2.6	Total	315,264	

VOLUSIA GRAVELLY LOAM.

The surface soil of the Volusia gravelly loam, to the average depth of about 10 inches, consists of a light-brown friable loam containing a large proportion of shale chips and some rounded gravel. The subsoil is a yellow or dark-gray gravelly sandy loam, in depressions approaching a clay, and in other places becoming much more sandy. In some cases the sand of the subsoil varies considerably within a single field. This is due to the presence of sand deposits within the material from which the soil is derived.

Volusia gravelly loam occurs largely within the valleys among the high hills in southern Tompkins County. It is derived from the sandy and gravelly morainal deposits, and the topography is consequently rather rough. The soil is well drained, and except for its rough topography is not difficult to till. Its occurrence in small areas makes it difficult to specify any crops to which it is particularly well adapted. Among the grain crops corn is grown to advantage on

account of the fact that this soil is well drained and warm. When Volusia gravelly loam occurs in small areas it is used on many farms in Tompkins County for apple orchards. The excellent drainage of the type renders it particularly adaptable for such purposes. Grass, oats, corn, buckwheat, potatoes, and beans are also grown on this type, producing about the average yields for Tompkins County. Except for its limited occurrence this soil would be one of the most valuable corn soils in the county, not so much on account of the large size of the crops which are produced as because of the fact that corn is matured upon it nearly every season.

VOLUSIA CLAY LOAM.

The soil to a depth of 6 or 8 inches is a heavy loam or clay loam of a dark-yellow or brown color. The subsoil is a pale-yellow or drab clay loam, which is decidedly clayey in texture in local areas of naturally poor drainage. The soil and subsoil contain from 5 to 15 per cent of shale chips with but few large pieces. Large foreign boulders may be observed, but are not abundant. The deep subsoil in fresh cuts is a dark-blue color and contains moderate amounts of shale and occasional large erratic boulders.

The type occurs in the southwestern part of the county in the towns of Enfield and Newfield, between the elevations of 1,100 and about 1,600 feet and almost entirely on northern and northeastern slopes. The topographic features are not rough, but the surface of all of the areas has a marked slope. In but few instances is this sufficient to interfere seriously with cultivation.

The natural slope of the surface aids in drainage over most of the areas, but the soil is sufficiently fine textured and dense to prevent the rapid movement of water through it, and where the surface is fairly level, as in a few places, the drainage is defective. Much of the type would be benefited by underdrainage.

This type of soil has been formed by glacial action similar to that which has formed the Volusia silt loam and the Miami stony loam, and it is not clear why the material in these areas should be of a finer texture than the areas of soil adjoining it on the uplands. It may have been influenced by the lake conditions which formed the Dunkirk soils. In one place it shows a distinct relation to the Dunkirk clay loam. This is in the valley a half mile northwest of Enfield Falls at an elevation of about 1,050 feet, where cuts of stratified Dunkirk clay may be observed. In this place the clay is covered by a stony clay loam deposit and the material might be classed with the Dunkirk stony clay type if it were of greater extent. Deep cuts of till are exposed a half mile farther up Fivemile Creek.

Field practices indicate that the type is best suited to fine-rooted crops like the grasses. Wheat, oats, rye, and timothy do best, and

corn not so well. Clover grows well in the summer months, but owing to the poor drainage of much of this soil it is "heaved" seriously in winter, so that the crop has been short lived. Some good growths of timothy and clover were observed on this type. Alfalfa is being tried, but thus far the success has been indifferent, probably because of poor drainage conditions. A small field of 1905 seeding, which had been inoculated, was looking very well when ready for the first cutting in the early part of August.

The farms on this type of soil are mostly in good condition, and on the average are much better than those on the Volusia silt loam with which it joins on the south.

Drainage, deep plowing, and the generous use of green and barn manures in connection with about 1,500 pounds of lime once in four or five years will probably give best results on this type of soil.

VOLUSIA SILT LOAM.^a

The soil of the Volusia silt loam to an average depth of 8 inches is a light-brown to yellow silt loam. The subsoil from this depth to a depth of 36 inches is a light lemon-yellow, light-gray, or mottled gray and yellow soft silty loam. Both the soil and subsoil contain a large amount of flat, slaty, angular fragments of shale from several inches to a foot or more in breadth and length. In addition, both the soil and subsoil contain a considerable quantity of very finely divided shale fragments, locally known as shale gravel. The presence of these stones, both of large and small size, tends to make the soil appear of somewhat lighter texture than it really is. They materially aid in the drainage of the type. Over a considerable part of the area occupied by the Volusia silt loam rock is present beneath the subsoil at a depth of from 18 inches to 3 or 4 feet. Occasionally the depth of soil and subsoil reaches 12 or 15 feet in areas where small moraines have been formed.

The surface of the Volusia silt loam is hilly to rolling. The type occupies the more gently rolling or flattened tops of the high elevations in the southern part of the county, and also extends down the sides of many of the steeper hills. The natural drainage is fair, but many springs break out from crevices in the rocks and form small swampy areas an acre or more in extent. These have not been separated from the main body of the type.

The Volusia silt loam in the early days supported a growth of oak and chestnut on the higher ridges, white pine upon the more level

^aThis type was first mapped in the Bigflats area, Chemung County, N. Y., where it was called the Hagerstown shale loam. Upon a further study of the general region the present classification of this type has been found necessary. The change is one in type name only, and is made to show the true relationship of this soil to other soils of the region.

areas, and a thick growth of hemlock along the steeper slopes and in the gorges. The greater part of this timber was long ago cut off, and only a few scattered patches of woodland remain upon the slopes, which in general are too steep for cultivation. Other steep slopes are used for pasture.

Owing to its peculiarities of texture and its occurrence at a considerable elevation, the Volusia silt loam in Tompkins County is best adapted to the production of grass, oats, and buckwheat. Among the grasses, timothy, reedtop, and bluegrass are grown to best advantage. The type is not particularly esteemed for the production of clover. In the Tompkins County area it is generally recognized as peculiarly adapted to the production of Irish potatoes. In many instances farmers reported that "the yellow loam soil on the hills was the best and surest potato soil in Tompkins County," and the wholesale and retail grocers in Ithaca also reported the best grade of potatoes as being grown in the townships where this type predominates.

On account of its position, lying from 1,000 to 2,000 feet above sea level, the Volusia silt loam does not constitute a corn soil in Tompkins County. In favorable seasons, when frost is not experienced until a late date, good yields are secured. The growing season is usually so short that considerable risk attends corn production on the type, especially where a yield of grain is desired. It would be possible for farmers to produce the short-season varieties of corn for ensilage. As a rule the cornfields in the region of the Volusia silt loam are of limited extent, not more than 2 or 3 acres on the majority of farms.

The Volusia silt loam produces an average yield of a scant ton of hay per acre; 12 to 20 bushels of buckwheat; 25 to 30 bushels of oats, and 80 to 125 bushels of Irish potatoes without spraying and with very meager care.

The type should be used for cattle and sheep production in order to utilize its known capabilities for the production of hay and oats. Turnips can also be grown. For a "money crop" buckwheat or potatoes are best suited to this type. In this connection it is well to hold in mind that partially rotted buckwheat straw plowed in before a potato crop is planted largely improves both the quantity and quality of the crop.

The location of the Volusia silt loam, where transportation by wagon is rather difficult, makes the raising of cattle and sheep a more promising line than the growing of bulky grain products or hay, which must be hauled to market at considerable expense.

The Volusia silt loam where the depth of surface soil and subsoil is 3 feet or greater, and where drainage is also good, is well suited to the production of winter apples like the Baldwin, Spitzemberg,

and Greening. Many small and poorly cared for orchards furnish proof that modern systematic orcharding on a commercial scale would prove profitable. The difficulty of hauling out the apples when grown and packed would be the only great drawback.

The following table gives the average results of mechanical analyses of the fine earth of both the surface soil and subsoil:

Mechanical analyses of Volusia silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
11277, 12284, 13315, 13317.	Soil -----	2.1	3.6	1.5	3.4	7.2	54.1	27.6
12278, 12285, 13316, 13318.	Subsoil ----	3.7	4.8	1.8	3.7	7.0	50.6	28.2

In order to obtain an idea of the manurial requirements of this type a large sample was collected about 3 miles east of Ithaca. The soil here is a brown silt loam containing about 25 per cent of shale fragment, and has a depth of 10 inches. The field from which the sample was taken has been in cultivation for fully a hundred years and is now in rather poor condition. Grass, oats, and potatoes have been the chief crops, and now yield an average of 1 to 2 tons of hay, 50 to 70 bushels of oats, and 30 to 50 bushels of potatoes per acre. Stable manure is used in small to medium applications, but no other fertilizers are employed.

The results of the examination of this sample by the wire-basket method indicate that stable manure produces a marked beneficial effect in increasing the productiveness of this soil; that sulphate of potash, alone or in combination, produces a fair increase; that nitrate of soda, acid phosphate, and lime, either alone or in various combinations, had little effect.

These results are held to be strictly applicable only to the field from which the sample was taken, but the use of stable manure is of recognized value in this area, and potash may be equally valuable on other farms on this type that are in similar condition. These results are also in accordance with the best farm practice and with actual field results.

VOLUSIA LOAM.

The surface soil of the Volusia loam to an average depth of 8 inches is a soft, slightly gritty loam, usually of a brown color when moist and of an ashy or yellow color when dry. The subsoil from 8 to about 24 inches is a pale-yellow loam. Below 24 inches the subsoil frequently contains a considerable quantity of very finely divided shale fragments, which gives it a somewhat gritty or sandy feel. In

areas where the soil has been plowed in a wet condition and to about the same depth year after year a "hardpan" is frequently developed at the depth at which the plow sole travels. Like all the soils of this series the Volusia loam contains a considerable proportion of flat slaty shale and sandstone, and the same rock more finely divided is present in such quantities that the soil is locally known as "black gravel" soil.

In Tompkins County the Volusia loam occupies the gently rolling to hilly plateau country of the northern townships, lying at an elevation of 1,000 to 1,700 feet above sea level. The greater part of the type is fairly well drained naturally, but depressed areas, extremely level tracts, and portions of the type where the soil is underlain at shallow depths by impervious rock are frequently poorly drained. This lack of drainage is shown by the presence of stagnant water during spring and fall, by the growth of water-loving grasses, and in the soil itself by a mottled gray and yellow appearance of the subsoil.

The Volusia loam is in general cleared and cultivated to various farm crops. Of these hay, oats, buckwheat, corn, rye, and a little barley occupy the chief acreage. Upon the Volusia loam in Tompkins County the usual farm practice includes corn or buckwheat, oats or wheat, and then hay for three to five years in the rotation. When handled to the best advantage, and particularly when stable manure is used, the Volusia loam produces about 1 to $1\frac{1}{4}$ tons of hay per acre, 25 to 35 bushels of shelled corn, 30 to 40 bushels of oats, 12 to 18 bushels of buckwheat, about 18 bushels of barley, and 85 to 125 bushels of potatoes. Corn is a more certain crop than on the Volusia silt loam, and potatoes are not produced to as good advantage as upon that soil.

Numerous small orchards of apples are found on the Volusia loam. Those which are well cared for produce good fruit in satisfactory quantities. Apple orcharding is, however, entirely a subordinate interest. The production of hay, of oats, and of buckwheat to less extent are the principal purposes to which the type is put. In the northeastern portion of the county a considerable dairy industry has become established, chiefly on this type. The farms in this region are usually in a high state of cultivation, well improved with good buildings, and well cared for and pleasing in appearance. Land values are correspondingly high, and very little complaint is made of "worn-out" or unproductive soils. Such a condition can be attained upon this type in other parts of Tompkins County, provided the grains and grasses are devoted to stock feeding and the resulting resources in stable manure are carefully husbanded and used.

The following table shows the average texture of this soil:

Mechanical analyses of Volusia loam.

Number.	Description.	Fine gravel. Per cent.	Coarse sand. Per cent.	Medium sand. Per cent.	Fine sand. Per cent.	Very fine sand. Per cent.	Silt. Per cent.	Clay. Per cent.
11283, 12288, 12290.	Soil -----	8.5	5.1	2.9	9.3	9.5	42.7	26.5
11284, 12289, 12291.	Subsoil -----	8.6	5.9	3.3	10.5	8.6	43.8	24.1

The manurial requirements of this type were investigated in the laboratory, using a large sample collected about 5 miles south of Ithaca. The field from which the sample was taken was typical of this soil. It had been in cultivation for eighty to one hundred years. The crops are grass, corn, oats, and potatoes. An average yield of $1\frac{1}{2}$ tons of hay, 40 bushels of oats, and 100 bushels of potatoes per acre is secured. Corn in favorable seasons yields well—80 bushels of corn in the ear per acre in 1905. Little stable manure and no other fertilizers are used and the farm is badly run down.

The result of the examination of this sample by the wire-basket method indicates that stable manure produces a large increase in the productiveness of the soil; that nitrate of soda and sulphate of potash alone gave a slight increase, while in combination they produced a marked beneficial effect; and that phosphate alone or in combination had little effect. Green manure and lime had a moderate effect and lime alone gave only a slight increase. Indications point to the conclusion that, on this run-down farm, in addition to stable manure, complete fertilizers with lime and green manures with lime could be used to marked advantage.

These results are held to apply only to the field from which the sample was taken, but the beneficial effect of manure agrees with the general practice on the type in this locality. The effect of mineral fertilizers might not be so marked on farms in a better state of productiveness.

VOLUSIA STONY LOAM.

The Volusia stony loam, to a depth of about 8 inches, consists of a heavy dark-brown loam containing a large quantity of flat shale and also a considerable proportion of rounded stones or cobbles. The subsoil, extending from 8 inches to 36 inches, is made up of a light loam or in many instances of a somewhat sandy loam containing large amounts of stone and gravel. The subsoil is so stony that great difficulty was encountered in making borings to a depth greater than 12 or 18 inches.

The Volusia stony loam occupies long slopes reaching from the valleys upward along the flanks of the high plateau country in southern Tompkins County. The type in its lower basal portion frequently

consists of a heterogeneous mass of local and glacial material dumped by the glacial ice as a massive moraine. Owing to its position at the foot of steep slopes, the torrential streams descending from the plateau region have carried down rock, gravel, and fine soil, spreading them out over the older morainal deposits. The result has been that a soil of a double origin, partly glacial and partly colluvial wash, has been formed. Even at the present day heavy storms are followed by additions of stone and soil brought down through the small gorges which cut back into the higher hills.

The Volusia stony loam lies in such a position that the seepage waters of the adjacent high hill country flow down through the subsoil of the type. This gives it natural subirrigation, forming springy and wet areas of greater or lesser extent throughout the type and particularly at or near the foot of slopes. In such cases artificial drainage is necessary and is practiced by the best farmers. In a season of drought this peculiar drainage condition is a distinct advantage, since a considerable part of the moisture which falls at higher elevations is thus made available to the crops.

The yields secured from the greater part of the Volusia stony loam are rather above the average of the county for all field crops, except possibly potatoes. Timothy yields from 1 to 2 tons; oats, from 25 to 40 bushels; buckwheat, 15 to 25 bushels, and potatoes 80 to 100 bushels per acre. Some beans and a considerable quantity of rye are grown on portions of this type.

On well-drained areas of the Volusia stony loam, particularly on northern and northwestern slopes, apple orchards are highly successful. Several new orchards have been set out in the last few years, and many farmers are recognizing that drainage and exposure play an important part in the success or failure of such attempts.

On account of its position along well-traveled roads of easy grades, because of its generally high repute for successful crop production, and also because of a general prevalence of good farm improvements, farms located on this type, which are for sale, bring good prices.

The following table gives the physical characteristics of the fine earth particles of this type, the figures being averages of determinations in the analysis of several samples:

Mechanical analyses of Volusia stony loam.

Number.	Description.	Fine gravel. <i>Per cent.</i>	Coarse sand. <i>Per cent.</i>	Medium sand. <i>Per cent.</i>	Fine sand. <i>Per cent.</i>	Very fine sand. <i>Per cent.</i>	Silt. <i>Per cent.</i>	Clay. <i>Per cent.</i>
11281, 13313	Soil	3.0	4.5	2.8	6.8	13.0	47.8	22.9
11282, 13314	Subsoil	2.8	4.8	5.8	14.0	14.3	38.0	20.1

MIAMI STONY LOAM.

The surface soil of the Miami stony loam to an average depth of about 9 inches is a mealy, light-brown loam. This is underlain by a brown or mottled gray and brown loam subsoil, extending to a depth of 40 inches or more. Both soil and subsoil contain a considerable quantity of rounded stone from 1 or 2 inches to more than 1 foot in diameter. The subsoil in particular is stony or gravelly. A large part of the stone found in the type consists of limestone derived from the Tully and from other limestone outcrops to the north and brought into the region by the glacial ice.

The Miami stony loam in Tompkins County marks an extreme southern extension of the type in central New York, and possesses an undulating or sloping topography, with generally good surface drainage. Considerable areas of this soil have been mapped in the Lyons area, around Syracuse, and in Cayuga County. Throughout central New York the Miami stony loam has the reputation of being a strong, lasting, general farming soil, well adapted to grass and grain production, well suited to apple orcharding, and in general desirable.

In the Lyons area sugar beets are produced on the type, yielding 8 to 11 tons per acre. In the vicinity of Syracuse and Fayetteville alfalfa has been grown for a considerable time. The average yield per acre near Fayetteville is $2\frac{1}{2}$ to 3 tons of alfalfa hay per acre. The crop is produced to advantage on Miami stony loam wherever the drainage conditions are good and the depth of soil and subsoil exceeds 3 feet. Apples are a prominent crop on this soil in Wayne County and westward in New York State.

In Tompkins County the Miami stony loam produces from 1 to $2\frac{1}{2}$ tons of hay per acre, 30 to 50 bushels of corn, 30 to 40 bushels of oats, and 18 to 25 bushels of winter wheat. Farms on this soil type are valued at \$35 to \$50 an acre or more, depending upon the conditions of improvements and upon the state of cultivation.

The following table gives the results of mechanical analyses of the fine earth of this type:

Mechanical analyses of *Miami stony loam*.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
11331.....	Soil.....	2.9	4.2	3.5	10.0	15.6	35.1	28.7
11332.....	Subsoil....	2.2	4.3	3.7	11.6	16.1	36.9	25.1

A large sample of this type was collected about $1\frac{1}{4}$ miles southwest of Lansingville, in order to investigate its manurial requirements. The field from which the sample was taken has been in cultivation

for about one hundred years, cropped mostly to corn, oats, and grass, with some wheat and barley. Only small to medium quantities of stable manure are used and no other fertilizers. The yields average 80 to 100 bushels of corn in the ear in seasons favorable to maturity of this crop, 50 to 60 bushels of oats, 25 to 35 bushels of wheat, 35 bushels of barley, and 2 tons of hay per acre.

The results of the experiments with this soil indicate that stable manure has a moderate effect in improving the condition of this soil, that green manure and lime give fairly good results, and that nitrate of soda, sulphate of potash, and acid phosphate and lime alone or in various combinations produce little or no increase in its productivity. These results were anticipated from the condition and crop-yielding capacity of this soil in the field, and are in accord with the experience and practice of the best farmers on this type, with regard to general farm crops.

DUNKIRK GRAVELLY LOAM.

The surface soil of the Dunkirk gravelly loam, to a depth of about 10 inches, is a brown gravelly loam. The subsoil to a depth of 36 inches is either a gravelly loam or a coherent loamy gravel. In addition to a large quantity of gravel, both soil and subsoil in small local areas contain large quantities of cobbles and flat shale fragments. This is due to the fact that the type has been formed by stream action and where streams have flowed across portions of the type local stony patches and strips have resulted.

The Dunkirk gravelly loam in Tompkins County is found chiefly in long, narrow terraces bordering the larger stream courses. These terraces are not usually subject to overflow at the present time, and with the exception of small sloughs are usually well drained and fertile. Only small areas of the Dunkirk gravelly loam are found in Tompkins County. Nearly all of them are under cultivation, producing large crops of corn and fair crops of hay and oats. Potatoes, beans, and peas also do well on this type. Small strips of the Dunkirk gravelly loam still subject to occasional overflow are also used for pasture.

The average texture of this soil is shown by the following table:

Mechanical analyses of Dunkirk gravelly loam.

Number.	Description.	Fine	Coarse	Medium	Fine	Very fine	Silt.	Clay.
		gravel.	sand.	sand.	sand.	sand.	Per cent.	Per cent.
11275, 13311.....	Soil	3.8	5.6	4.0	10.8	16.8	42.5	16.3
11276, 13312.....	Subsoil	5.0	8.2	6.3	15.6	19.1	31.3	14.4

DUNKIRK GRAVELLY SANDY LOAM.

The Dunkirk gravelly sandy loam, to an average depth of about 1 foot, consists of a brown or yellow sandy loam containing a large percentage of rounded gravel and small stones. In fields which have been well supplied with organic manures the surface soil is distinctly brown and loamy. Elsewhere the surface soil is yellow and its sandy character is much more evident. The subsoil usually consists of a very gravelly yellow or gray sand with distinct stratification into sand and gravel layers. The whole mass is usually many feet thick, except along the margins, where it rapidly thins out.

In Tompkins County the Dunkirk gravelly sandy loam occurs as deltas deposited in former glacial lakes by rapidly flowing upland streams. In many cases a series of these flat-topped gravelly deltas extends up along the present hill slopes. This characteristic is marked at Coy Glen along Fall Creek and even in the vicinity of the smaller creeks and gorges along the Cayuga Lake slopes. A portion of the Cornell Experiment Station farm includes this soil type and many experiments have been conducted upon it. The potato experiment, in which large increases in yield were obtained by thorough cultivation and without fertilizer or manure, was conducted on this type.

In general the Dunkirk gravelly sandy loam is a light, somewhat leachy soil not well adapted to grass or wheat production, but constituting an excellent corn and potato soil. With careful cultivation, which should include the liberal use of organic manures, it is capable of producing large yields of corn, potatoes, and clover. Owing to the fact that a large part of the type lies adjacent to Cayuga Lake and because of the sandy and gravelly nature of the soil, the Dunkirk gravelly sandy loam is well suited to the production of peaches. Such areas as occur within one-half to 1 mile of Cayuga Lake are within the tempering influence exerted by that body of water upon the climate of the region. This climatic peculiarity added to the loose structure and porous texture of the soil results in conditions favorable to peaches, and the majority of the best orchards are found on the type. The area of Dunkirk gravelly sandy loam south of Taghanic Creek is almost entirely devoted to fruit, including some fine peach orchards, and should serve as a field experiment to direct the further planting of orchards along the Cayuga shores.

The yields of ordinary farm crops upon the Dunkirk gravelly sandy loam are only moderate and the type should be used as a fruit, potato, and corn soil.

The following table gives the texture of the type, the figures representing the averages of several determinations:

Mechanical analyses of Dunkirk gravelly sandy loam.

Number.	Description	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
1074, 13291.....	Soil	12.4	13.0	5.1	16.5	13.9	24.7	14.3
10765, 13292.....	Subsoil	12.5	17.2	6.4	24.4	13.1	13.8	12.3

DUNKIRK STONY CLAY.

The surface soil of the Dunkirk stony clay, to a depth of about 8 inches, consists of a yellow or brown heavy loam or clay loam. The subsoil, from 8 to 36 inches or more in depth, consists of a chocolate colored or mottled brown and gray clay. Both surface soil and subsoil contain varying proportions of rounded and angular stones. Frequently a large part of any single field is only slightly stony, while small areas and long narrow bands will contain enough stone seriously to interfere with cultivation. On the best managed farms the stones have frequently been gathered into piles or built into road or boundary fences. The entire mass of soil and subsoil usually rests on shale or sandstone rock at a depth varying from 18 inches to 5 or 6 feet.

The Dunkirk stony clay occupies sloping to steep areas along both sides of Cayuga Lake and along the margins of the tributary valleys to an average elevation of about 600 feet above lake level. It is also found in several of the smaller glacial lake areas near Dryden and in the upland valleys. The type represents the fine clayey sediments deposited in the bygone lakes, together with glacial boulders and local sandstone and shale also carried into these areas by various means. Along the Cayuga Lake shore a considerable part of the type has been formed by the erosion of what were formerly areas of Dunkirk clay loam. The fine earth of the original type has been carried away and redeposited elsewhere, while the stones, which were previously scattered through a considerable depth of soil and subsoil, have been left behind to accumulate upon the surface of the type as it now exists. This rapid erosion still continues and constitutes one of the most serious problems in the management of the Dunkirk stony clay. Lying as it does on steep slopes, every heavy storm sends small temporary streams across its surface, frequently washing gullies across the tilled fields. The surface of the type also bakes and compacts and a large proportion of the rain which actually falls upon it rapidly flows off, carrying away in suspension much surface soil. No large amount of erosion occurs at any one time, but the removal under ordinary methods of tillage is on the whole so rapid that the farmer is usually under

the necessity of farming the subsoil instead of the soil over some parts of his fields.

The Dunkirk stony clay is farmed to wheat, corn, and grass, producing low yields in the majority of cases. In the vicinity of South Lansing there are several very well-tilled farms upon this type which are producing good yields. Elsewhere in Tompkins County the yields are less. In general about 1 ton of hay, 20 to 30 bushels of corn, and 12 to 18 bushels of wheat per acre constitute good average yields.

The Dunkirk stony clay is well suited to the production of wheat, oats, and hay, where the surface slope is not too great or where careful farming prevents too rapid surface erosion. By the use of lime and stable manure yields of 2 tons of clover and 25 bushels of wheat have been produced upon this type in recent years. This soil should be kept in grass as much as possible in order to hold the surface soil in place. Upon steep slopes the plowing and cultivation should be done by the contour system, as employed in the southern States. By this method the rows and furrows are carried nearly horizontally around slopes. When, in addition, uncultivated bands of sod are left also running horizontally along the slope the continual loss of surface soil can largely be prevented.

Among fruits, apples and pears are well suited to the Dunkirk stony clay. Within a distance of one-half mile to 1 mile from Cayuga Lake grapes are also grown to advantage. In setting out vineyards the rows should run horizontally and not up and down hill. One vineyard of the latter class was seen where the upper ends of the intervals between vine rows consisted of deep gullies and the lower ends were piles of mingled stones and earth. This ruinous erosion could have been prevented by running the rows horizontally.

The following table gives the average results of mechanical analyses of typical samples of this soil:

Mechanical analyses of Dunkirk stony clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
11403, 12282.....	Soil	0.8	1.7	2.3	11.2	18.6	43.9	26.1
11404, 12283.....	Subsoil	1.1	1.6	1.9	9.2	12.4	35.9	37.7

DUNKIRK CLAY LOAM.

To a depth of about 8 inches the surface soil of the Dunkirk clay loam consists of a brown or yellow heavy loam. The subsoil to a depth of over 36 inches consists of a chocolate-brown silty clay or of the same material mottled brown, yellow, and gray.

This soil when wet is sticky and plastic. Upon drying the surface cracks into irregular masses and polygonal blocks. Frequently when the surface of a cultivated field is stirred when wet the soil settles into an almost cementlike mass.

Over the greater part of the type the surface is level to gently undulating. Drainage is fair to poor and needs to be supplemented by tiling on a majority of the farms.

The Dunkirk clay loam consists of glacial material reworked by streams and redeposited in glacial lakes and ponds as a quiet water sediment. The subsoil is frequently stratified or laminated. Only occasional stones or boulders occur on the surface of the type, but near its margins some stones have become mingled with the soil. When only a thin sheet of the type occurs covering glacial deposits the stones from the latter sometimes work up into the soil.

The Dunkirk clay loam is an exceedingly heavy silty clay loam marked by massive structure, by plasticity when wet, and by a considerable degree of compactness when dry. It is a type of soil adapted to the production of oats, wheat, timothy, and bluegrass. It is not a favorable soil for potatoes or corn, and the yields of these crops on this type in Tompkins County are not usually satisfactory. Over the type in general the hay yield is 1 to $1\frac{1}{2}$ tons per acre; that of corn 25 to 30 bushels. Oats produce 40 bushels or more, wheat about 20 bushels, and potatoes 80 to 100 bushels per acre.

A considerable proportion of the Cornell Experiment Station farm is occupied by the Dunkirk clay loam, which has here been brought to a high state of cultivation. Hay has yielded 4 to $4\frac{1}{2}$ tons, wheat 35 to 42 bushels, and oats frequently 60 to 80 bushels per acre. These results were secured by good drainage, careful tillage, and the liberal application of stable manure in connection with small amounts of mineral fertilizers. A four-year rotation of corn, oats, wheat, timothy, and clover is practiced. Clover freezes out badly on the type and can only be grown where the drainage conditions are the best.

In the production of corn upon this type the experiment station has found that the grain can not always be matured, and it is better to produce corn for silage purposes. From 15 to 20 tons of excellent silage per acre have been produced. Mangels also yield heavily, giving as high as 45 tons per acre.

While such results probably can not be secured under the ordinary necessities of farm practice, at the same time they serve to indicate the wonderful possibilities of this soil for crop production under intensive systems of culture.

The Dunkirk clay loam is a very good grass and small-grain soil. It should produce crops for cattle and dairy feeding, and would bene-

fit from such a system of agriculture, because it needs organic fertilizers.

The following table gives the average results of mechanical analyses of typical samples of this type:

Mechanical analyses of Dunkirk clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
10760, 10762, 13299, 13301.	Soil -----	0.5	1.1	0.8	3.4	7.3	56.8	29.9
10761, 10763, 13300, 13302.	Subsoil ----	.4	.7	.5	1.5	4.7	56.9	35.0

In order to obtain an idea of the manurial requirements of this type a large sample was collected about 2 miles east of Ithaca. The soil consists of a brown heavy silt loam and was sampled to the average depth of cultivation, about 6 inches. The underlying subsoil is a clay loam, and the soil is retentive of moisture to a degree that makes it cold and late. The field from which the sample was taken has been in cultivation for more than fifty years. Grass, oats, and corn are the chief crops and are grown in a somewhat regular rotation. Moderate applications of stable manure have been used, and no other fertilizer. The yields on this farm average $2\frac{1}{2}$ tons of fine quality hay per acre, 50 to 70 bushels of oats, and 50 to 60 bushels of corn in the ear in favorable seasons.

The sample from this farm was subjected to tests in wire baskets, and the results obtained indicate that, using wheat as an indicator, stable manure has a highly beneficial effect on the soil; that nitrate of soda and sulphate of potash separately improve the soil slightly, while in combination in equal proportions they produced a fair increase in productivity. Acid phosphate and lime alone or in combination with other elements of fertility have little or no beneficial effect. These results were obtained under favorable climatic conditions for the crop and by having the soil in the best possible condition both physically and as regards to moisture content. Lime might prove of decided benefit in the field from its physical effect on soil texture and structure, but this action has been largely eliminated under the conditions of the test.

These results are held to be applicable only to the field from which the sample was taken, but they are in agreement with the general practice on this type in the area and with the experience of the farmers.

DUNKIRK LOAM.

The Dunkirk loam possesses a mealy brown or yellow loam surface soil, which reaches to an average depth of about 10 inches. This

surface soil contains highly variable proportions of very fine sand. In general the surface soil is sufficiently sandy to be distinctly friable. At the same time enough silt and clay are present to cause it to pack and even to form clods when tilled in a wet condition. From 10 to 24 inches in depth there is frequently present a layer of light-gray or yellow loamy fine sand. This may be lacking, however, over a considerable proportion of the type. In general the surface loamy material grades imperceptibly into a sandy clay or a clay loam at a depth of 24 to 36 inches. Where the surface soil has been subject to erosion, as on steep slopes, the underlying clay often appears nearer the surface.

A moderate amount of flat shale and sandstone fragments occurs in both soil and subsoil. The quantity of stone present increases near the boundaries of the type and on steep slopes.

The Dunkirk loam constitutes a marginal deposit of old glacial material reworked and redeposited in Glacial and post-Glacial lakes. It is most widely developed along the shores of Cayuga Lake, along the east side of Salmon Creek, and in the vicinity of Dryden Lake. Its surface is sloping to steep, although certain areas around Dryden Lake are more nearly level.

The soil type is extensively planted to pear, peach, cherry, and plum orchards in Ithaca Township along the slopes on the west side of Cayuga Lake. It is also used for fruit culture in Seneca and Cayuga counties, and many successful orchards are located upon it. Where the surface slopes are not too steep, it also constitutes a good general farming type. It is better suited to corn and potatoes than the heavier Dunkirk clay loam, and, on the other hand, its yields of grass and small grain exceed those of the Dunkirk gravelly sandy loam.

Frequently the more level or depressed areas of the Dunkirk loam would be benefited by underdrainage. Some stone and some tile drains, have been laid under this type, and they have always given satisfactory results when properly laid.

The use of stable manure and of green manures upon the Dunkirk loam is attended by better results than the use of chemical fertilizers, according to the testimony of several progressive farmers located on this type. Crop yields amounting to 20 bushels of wheat, 35 bushels of corn, 1 to 1½ tons of hay, and 40 bushels of oats are obtained in average seasons. Some buckwheat is annually sown, and potatoes constitute one of the minor crops produced on this soil.

The following table gives the average results of mechanical analyses of both soil and subsoil of this type:

Mechanical analyses of Dunkirk loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
11279, 11354, 12286.	Soil -----	1.5	2.3	2.2	12.4	20.0	43.1	18.0
11280, 11355, 12287.	Subsoil ----	1.3	2.7	1.8	9.5	21.0	43.3	20.0

Wire-basket tests were made of a large sample of this type of soil, collected about 2 miles west of Ithaca. The soil here consists of 8 to 10 inches of brown silty loam containing some rock fragments. The sample was taken to the average depth of cultivation—about 6 inches. The field is well drained, warm, and early, and has been in cultivation for seventy or eighty years. Corn, oats, hay, wheat, buckwheat, and truck are the important crops. The yield averages, in favorable seasons, from 40 to 60 bushels of corn, 40 to 60 bushels of oats, 15 to 20 bushels of wheat, 20 to 25 bushels of buckwheat, and $1\frac{1}{2}$ to $2\frac{1}{2}$ tons of hay per acre. Some stable manure is used, but no other fertilizers.

The results of the examination of this sample indicate that stable manure has a marked effect on the productiveness of the soil; that nitrate of soda is fairly beneficial, and that sulphate of potash, acid phosphate, and lime alone or in various combinations are of little or no benefit. These results were obtained under climatic conditions favorable to the crop and with the soil in the best possible physical condition and moisture content. They are held to be strictly applicable only to the field from which the sample was taken, but they are in agreement with the general practice and best experience of farmers on this type of soil.

DUNKIRK FINE SANDY LOAM.

The Dunkirk fine sandy loam possesses a brown or yellow fine sandy loam surface soil, with an average depth of about 6 inches. The subsoil to a depth of 3 feet or more is a gray or yellow medium to fine sand. Both soil and subsoil contain varying quantities of fine gravel. The type is well drained and warm, and matures crops having a short growing season to better advantage than the heavier soils.

The Dunkirk fine sandy loam occupies nearly level flat-topped areas, which are usually minor stream deltas closely related in point of origin to the Dunkirk gravelly sandy loam. The largest area of this type is found in the vicinity of Taghanic Creek, south of Trumansburg. It is largely used for the production of small fruits, truck crops, and beans, and furnishes a good example of a case where the special adaptation of a soil to particular crops has been utilized in Tompkins County. Recently cucumbers for pickling purposes

have also been grown on the type. This crop has been introduced so recently that little could be learned concerning the soils best suited to its production. With some limitations, however, good results were secured on the Dunkirk fine sandy loam.

Both organic manures and commercial fertilizers are used extensively on this type, and those engaged in the production of the small fruit and truck crops were of the opinion that both kinds of fertilizers used together produced better results than either used alone.

The following table gives the results of mechanical analyses of typical samples of this type:

Mechanical analyses of Dunkirk fine sandy loam.

Number	Description	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
13297.....	Soil	1.3	4.3	4.3	23.8	32.5	24.1	9.3
13298.....	Subsoil	1.1	3.3	5.3	27.5	32.8	23.5	6.4

DUNKIRK SILT LOAM.

The surface soil of the Dunkirk silt loam to an average depth of about 9 inches is a yellow or brown friable silty loam. This is immediately underlain by a lighter colored silt or very fine sand, which usually grades down into a brown silty clay at about 30 inches in depth.

The type occupies knolls and irregular valley slopes in the West Danby Valley and consists of stratified or laminated lake deposits, which have been badly eroded. It is closely related to the Dunkirk loam, but differs in possessing more very fine sand and silt in the surface soil and in the upper portion of the subsoil.

Aside from its rather rough surface topography the type constitutes a good soil for general farming purposes, producing good crops of corn, 1 to 2 tons of hay, 20 to 28 bushels of wheat, and 40 to 60 bushels of oats per acre. The apple orchards on this type are productive, and the soil is well suited to apple culture. In former years peaches were cultivated to a considerable extent upon the Dunkirk silt loam. Orchards situated upon the slopes where drainage was good and the exposure favorable were thrifty and produced good crops of excellent quality. The business of peach production is not so extensively followed as formerly, but the opportunities on this type are good. Pears, plums, and cherries also do well.

The following table gives the average results of mechanical analyses of the Dunkirk silt loam :

Mechanical analyses of Dunkirk silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
13303, 13305.....	Soil	0.4	0.9	0.9	4.3	8.1	71.4	13.6
13304, 13306	Subsoil1	.6	.5	2.2	6.6	69.7	19.6

DUNKIRK SHALE LOAM.

The entire mass of the Dunkirk shale loam from the surface to a depth of 36 inches or more consists of flat, angular fragments of shale and sandstone several inches to 1 foot or more in breadth, mingled with a fine-grained brown loam containing considerable quantities of partially decayed organic matter. In some cases the loam changes to a gray or yellow color at a depth of about 18 inches.

The Dunkirk shale loam consists of low, flat, cone-shaped masses of stony material washed down by intermittent streams and piled up where the stream emerges upon more level land and on steep slopes along stream gorges. The larger areas are less noticeably conical, but all are sloping to steep. New material is added to many portions of this type with every flood and except for the difficulty experienced in tilling such a stony soil, the Dunkirk shale loam would constitute valuable land for grass and grain production. Corn produces good yields and oats, timothy, and clover do well. Many of the smaller areas are left in pasture, not only because of the rough, stony surface, but largely because unseasonable floods may completely destroy any cultivated crop.

The following table gives the results of mechanical analyses of this soil:

Mechanical analyses of Dunkirk shale loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	Percent.	Percent.	Percent.	Percent.	Percent.	Percent.
13307.....	Soil	2.2	5.8	1.2	1.2	3.2	53.7	32.6
13308.....	Subsoil9	6.7	18.6	43.7	9.7	12.7	7.6

WABASH LOAM.

The Wabash loam, to an average depth of 24 inches, consists of a brown mealy loam well filled with partially decayed organic matter and free from stone or gravel. The subsoil is usually a gray or drab loam, although small patches of blue clay subsoil occur in some localities. At a depth of 36 inches to 4 feet sand or gravel usually is found.

The Wabash loam consists of fine earth washed down by stream action from higher lying types and thoroughly mingled with considerable quantities of partially decayed organic matter. It occupies stream bottoms subject to overflow and also a large proportion of the Cayuga Inlet Valley, which was once a portion of the lake. The surface of the Wabash loam is nearly flat or gently inclined, and drainage is frequently poor. As a consequence the greater part of the type in Tompkins County is used for pasture or for meadow. Better drained areas, particularly near Ithaca, are also used to a small extent for the production of celery, cabbages, onions, and other truck crops.

The Wabash loam is badly in need of drainage. When well drained it produces excellent crops of corn and oats and is one of the best timothy soils in the area. In the Cayuga Inlet Valley the type should be protected as much as possible from overflow, and also drained by open ditches in order to furnish a rich productive location for market gardening. The fertility of the type is practically inexhaustible, and the Inlet Valley is situated favorably for extensive farming operations.

The following table shows the physical composition of the type:

Mechanical analyses of Wabash loam.

Number.	Description	Fine	Coarse	Medium	Fine	Very fine	Silt.	Clay.
		gravel.	sand	sand.	sand.	sand.	Per cent.	Per cent.
13309.....	Soil	0.3	1.4	0.9	6.9	18.4	51.0	21.1
13310.....	Subsoil	11.3	13.9	2.4	1.9	3.0	45.4	21.8

ROUGH STONY LAND.

Throughout the southern portion of Tompkins County and also along the shores of Cayuga Lake there are many areas, included within different soil types, the surface of which is so steeply inclined that they can not readily be brought under cultivation. The soil is usually not markedly different from that of the adjoining or surrounding types, although there is often an excess of shale and sandstone fragments. Such areas have been mapped as Rough stony land.

These areas in Tompkins County are chiefly forested or to a less degree used for hill pasture. They should all remain forested, and in that condition would be of far greater value than if cleared and pastured. Although the surface of the county was originally covered by forests, practically all of this timber has been removed, and the supply still remaining in the county is very meager. There is an increasing necessity for reforesting at least the rougher, noncultivable land, in order that fuel, fence material, and lumber may again be produced for local use.

MEADOW.

Level or depressed areas of poorly drained land, some of which are subject to frequent overflow, have been classed as Meadow. This classification is based on the swampy condition of the material and not upon its texture or composition, which may vary greatly. The Meadow areas usually possess a dark mucky surface soil to a depth of several inches or even a foot or more. The meadows in the Cayuga Inlet Valley are particularly marked by this mucky soil, and in many instances a little artificial drainage would reclaim these lands. They would then constitute valuable soils for the production of such truck crops as onions, cabbages, and celery. Many of the upland Meadow areas are forested to water maple, birch, ash, and other water-loving trees. Other areas are cleared and included in pasture.

The majority of these areas owe their present condition to small local obstructions to the natural drainage, and a few open ditches, dug for short distances, would reclaim considerable areas of unsightly and unprofitable bogs. With land at its present price in Tompkins County no great expenditure of money would be justifiable for such drainage, but in a large number of cases a few days' work with teams, plows, and scrapers would greatly improve the drainage conditions.

These Meadow areas, when properly drained, are almost uniformly of high productiveness, and when once subdued they maintain their ability to produce crops for a considerable length of time.

AGRICULTURAL CONDITIONS.

In the early days of the agricultural development of Tompkins County the clearing away of the forests constituted the first duty of the settlers, and also for the first few years brought them their largest income. A few Indian fields existed in the vicinity of Cayuga Lake, and upon these the settlers grew their first crops. As the country became more thickly populated and the timber lands were cleared wheat became the important crop. The completion of the Erie Canal in 1825 and its connection with Cayuga Lake by means of a feeder afforded excellent facilities for the water transportation of this grain to the seaboard markets. As a result, all of that part of Tompkins County contiguous to Cayuga Lake became a wheat-producing section, and elevators were built at Ithaca and at various points along the shores of the lake. Many of these old structures have fallen into decay, but a few remain and are used for other purposes. When the Western States were settled and new wheat lands were developed, Tompkins County experienced a decline in the profitability of wheat culture, in common with other sections of the Eastern States producing this crop. As a result, large areas of land were devoted to the

production of oats, hay, and corn. The tendency toward grain production in Tompkins County has, however, survived until the present time, the production of grain and of hay still dominating the agricultural practice of the area. In 1899 hay occupied 66,725 acres of the cultivated land in the county. Nearly 24,000 acres were devoted to oats, over 16,000 acres to buckwheat, 13,000 acres to wheat, about 11,000 acres to corn, nearly 5,500 acres to potatoes, and less than 1,600 acres each to rye and barley. With the exception of the northeastern part of the county, a great part of the hay crop cut in Tompkins County is baled and sold. The meadows remain in sod for three or four years, and are then plowed and planted to corn or, in case of an unfavorable season, to buckwheat. These crops are followed either by oats or wheat, and after either of these crops the ground is again sown to grass. The rotations vary in different parts of the county, but follow this general outline.

The census of 1900 reports 81 per cent of Tompkins County as improved land. The average size of the farms is given as 71 acres, the average value per acre is \$20.90, and the average value per acre of the buildings is \$15.30, thus giving an average value of the farms with their improvements of \$36.20 per acre. The average figures of course mean little for particular farms. Farm values in Tompkins County range from \$6 or \$7 an acre in the more inaccessible, hilly regions to \$100 and \$125 an acre in the vicinity of Ithaca. The greater number of farms in the county can be purchased at prices ranging from \$30 to \$50 an acre, and upon these farms the improvements may be described as fair.

The average yield per acre of the principal crops produced in the county are a trifle below the average for the State. The census of 1900 gives the following: Hay, 1 ton; oats, $31\frac{1}{2}$ bushels; buckwheat, 12 bushels; wheat, 20 bushels; corn, 26 bushels; barley, 24 bushels; rye, 13 bushels, and potatoes, 103 bushels per acre. These yields are somewhat higher than those reported by the census of 1890. It will be seen, therefore, that the farms of this county are still producing from 18 to 20 bushels of wheat and about 1 ton of hay to the acre each year. The buckwheat crop is much more variable in its yields, and the corn crop depends almost entirely upon the weather conditions for the amount of grain returned per acre. At the time of making the soil survey of Tompkins County there had been two seasons unfavorable for corn, and it was a common sight to see fields that had been planted to corn harrowed over and replanted to buckwheat. In some instances corn of two different plantings and a crop of buckwheat could be seen growing in the same field. This practice of displacing an unpromising or backward growth of corn is common throughout central New York.

The northeastern part of Tompkins County is more generally devoted to dairying than any other part of the area. This may be due to two reasons. For one thing, it adjoins Cortland County, where dairying has been an important industry for a number of years and the practice has spread across the border into the northeastern townships of Tompkins County. Another reason is found in the excellent transportation facilities afforded by the railroads crossing this part of the county. There are several skimming and pasteurizing stations located at convenient points along the railroads. The milk is hauled from the farms to these stations, where frequently it is bottled before being shipped to the city. Most of it goes to New York City and Philadelphia. In times of surplus milk production, and in some cases throughout the year, the milk is skimmed and only the cream is shipped, or else made into butter. This section of the county presents a much more prosperous appearance than the remainder of the county. The buildings are in better condition and many of the farms are improved with comfortable houses, excellent basement barns, and silos.

Tompkins County, in common with a large proportion of New York State, is seriously troubled with the labor problem. There is a general complaint of the scarcity of help and the general impression is that a majority of the young men of the rural communities are leaving the farm and securing employment in the manufacturing towns. The wages paid farm laborers vary considerably in different parts of the county and also with the season. Day labor generally receives from \$1.25 to \$1.50. Laborers employed by the month receive from \$18 to \$22 a month with board, or \$25 to \$32 a month without board. The greatest scarcity of labor occurs during the months of July, August, and September; that is, during the hay and harvesting season. Under the prevailing system of grass and grain farming this scarcity of labor can not readily be overcome. Not only does the greatest demand for labor occur within this short season, but it occurs simultaneously all over that portion of New York State. The best farm laborers are not content to work, even at high wages, for three months in the summer and take their chances on securing occasional employment during the rest of the year. As a result, the more ambitious men rent farms, or secure employment in other agricultural regions where work is more continuous, or go to the manufacturing towns and secure regular work at regular wages. There seems to be but one remedy for this condition, and that is for the farms to be so managed that good labor can find employment during the entire year. This is not possible under the present system of grass and grain farming, but it is not only possible but absolutely essential under a well-organized system of dairying and

stock raising. In fact, in the dairying region of Tompkins County there is less discouragement over the labor situation than in the grass and grain farming districts.

The present development of agriculture in the county is far from satisfactory. Throughout the southern townships, though not confined to them, land is for sale at prices which would little more than pay for the improvements. During the progress of the survey over 150 vacant houses were counted in various parts of the area. These constitute the so-called abandoned farms of the northeastern States. Inquiry developed the fact that while the buildings were unoccupied the land was, in all cases, used for some agricultural purpose and was held either by some farmer nearby or by some one living in a town or city. The abandonment is one of houses rather than of land. Nevertheless, the situation is such as to promote a low grade extensive farming, instead of a high grade intensive cultivation of the land, and there seems to be a tendency for the smaller farms in the hilly districts to coalesce into large holdings. The average size of the farms for the county is not materially increased, however, since at the same time some of the larger farms in the vicinity of the towns are being broken up into smaller holdings which are used for the fruit, market gardening, and poultry industries. The average statistics for the county are, to this extent at least, somewhat misleading.

The low-priced farms of Tompkins County furnish an excellent opportunity for the young, progressive men, possessed of a small capital and capable of increasing the productivity and the value of these farms by the use of proper agricultural methods. These lands are still capable of producing about 1 ton of hay per acre, and fair crops of oats and buckwheat. Many of them are partially improved with fair buildings and neglected orchards. A change from grass and grain farming, which is becoming unprofitable, to dairying and stock raising is imperative.

A section of the county adjoining Ithaca and following both sides of Cayuga Lake is quite extensively devoted to fruit growing, the fruit belt being confined by climatic conditions to the vicinity of the lake. Here peaches, plums, pears, cherries, and apples are grown to good advantage. A few small vineyards also occur. Small fruits, such as raspberries and strawberries, are cultivated in small patches. The berries and garden products are sold only in the local markets. As a result, during some seasons of the year there is a glut and prices are extremely low, while at other seasons the vegetables and fruits sold in the local markets are imported from other regions. There has been little attempt to ship to distant points any other fruit than apples, except in the case of a few successful peach growers. There are several peach orchards north of Ithaca Township from

which shipments are made, and while the industry is only partially developed, those who are engaged in it have met with a fair degree of success. It was noticed during the progress of the survey that the finest peach orchards were located either upon the Dunkirk gravelly sandy loam or upon the Dunkirk loam. A few orchards planted upon the Dunkirk clay loam have produced only one or two successful crops in from five to ten years. Near Shurgers Point, to the northward along the east shore of Cayuga Lake, there are several vineyards. The largest of these comprises only 10 or 12 acres. Where these vineyards are properly cared for, good yields of grapes of excellent quality have been secured. In some instances, however, the vines have been planted with the rows running up and down hill, and erosion on the steep slopes has been so great that the vineyards are partially destroyed. The grape industry should prove profitable on the Dunkirk clay loam and the Dunkirk loam, in a belt about one-half mile wide on each side of Cayuga Lake.

It can scarcely be said that the county is a prominent fruit-producing region. Nearly every farm throughout the county has a few apple trees in the vicinity of the farm buildings. Only a few commercial orchards have been planted, however, and in the majority of cases instead of being confined to one or two varieties of shipping quality they have been planted to half a dozen kinds, so that no considerable output of any standard-grade apple can be secured from a single orchard. The buyers who make their headquarters in the counties south of Lake Ontario occasionally visit Tompkins County and secure some apples, but in the majority of cases the apples are shipped in quantities of a few barrels to the city commission merchants.

The conditions observed in Tompkins County indicate the necessity for a slow but decided change in the character of the agriculture of the area. The production of grass and grain can no longer be carried on at a profit. Only farmers of more than average ability, both in the technicalities of their occupation and of business management, are securing much more than a fair living. Without some form of animal husbandry the annual expenditure for commercial fertilizers makes considerable inroads upon the cash returns from the farms. Green manuring is practically unknown in the area, the use of lime was discontinued many years ago, and the farmers secure either a minimum of stable manure or small quantities of commercial fertilizers as their only assistance in producing crops.

One of the great problems confronting the farmers of Tompkins County is the prevention of rapid soil erosion along the steeper slopes. This is particularly true in the vicinity of Cayuga Lake, where the clays and heavy loams occupy slopes of 300 and 400 feet to the mile. The compactness of the soil tends to throw a large proportion of the rainfall into surface drainage, with consequent ruinous

effects accompanying every heavy storm. It is extremely difficult or impossible to maintain a proper surface soil over the subsoils under these conditions. Little or nothing is known of contour cultivation, although its introduction would improve the farm conditions on the steeper slopes.

There are several farmers in this general region who have, by the careful use of stable manure and the aid of an occasional green crop plowed under, maintained the producing power of their land at a point far above the average attained by their neighbors. These men furnish samples of what can be done by the use of proper methods of soil management. With the addition of lime still greater increases in crops could be secured. Upon the heavy clays and loams from 1,500 to 2,000 pounds of lime per acre should be used once during the four or five year rotation. With the use of lime clover seeding is practicable, but without it the seeding of clover is not infrequently so much seed and labor thrown away.

The local markets of Tompkins County are Ithaca, Dryden, Groton, and Trumansburg. At the latter place there is a bean-cleaning establishment, and also a recently established pickling plant, both of which furnish an outlet for agricultural products. The production of cucumbers for pickling is a new industry in Tompkins County, and its success or failure can not be predicted at the present time.

The transportation facilities are good. Two main lines of railroad enter the county, and nearly every part of the area is within 5 or 10 miles of a railroad station. Aside from the difficulty experienced in hauling heavy loads over the hilly roads the highway system is very good. The money system of highway improvement is followed in most of the townships, and the results have been much better than those obtained under the old system of working out the highway tax.

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SOIL
PROFILE

(3 feet deep)

Volumia
stony loam
Hsc

Volumia
gravelly loam
Sc
Sgc
Sgr

Volumia
loam
Sc
Scat

Volumia
silt loam
Sic
Sic

Volumia
clay loam
Scc
Scc

Dunkirk
gravelly
sandy loam
Ssc
S

Dunkirk
gravelly loam
Sc
Sc

Dunkirk
shale loam
Scc
Scc

Dunkirk
stony clay
Scc
C

Dunkirk
fine sandy loam
Scc
S

Dunkirk
loam
Sc
Cs

Dunkirk
silt loam
Sic
Sic

Dunkirk
clay loam
Hsc
Cs

Miami
stony loam
Sc
Sc

Wabash
loam
Sc

Soil
Loam
Gravelly loam
Coarse sandy
Sandy loam
Sandy loam
Fine sandy
loam
Sandy clay
Stony loam
Shale loam
Silt loam
Clay

LEGEND

Vs
Volumia
stony loam

Vg
Volumia
gravelly loam

VI
Volumia
loam

Vsl
Volumia
silt loam

Vc
Volumia
clay loam

Dg
Dunkirk
gravelly
sandy loam

Dgl
Dunkirk
gravelly loam

Ds
Dunkirk
shale loam

Dsc
Dunkirk
stony clay

Df
Dunkirk
fine
sandy loam

Di
Dunkirk
loam

Dsl
Dunkirk
silt loam

Da
Dunkirk
clay loam

Ms
Miami
stony loam

Wl
Wabash
loam

Rs
Rough
stony land

M
Meadow

LEGEND

Hsc Heavy loam

Sc Loam

Dg Gravelly loam

Sco Gravelly sandy

S Sandy loam

Sco Sandy loam

Fine sandy loam

Sandy clay

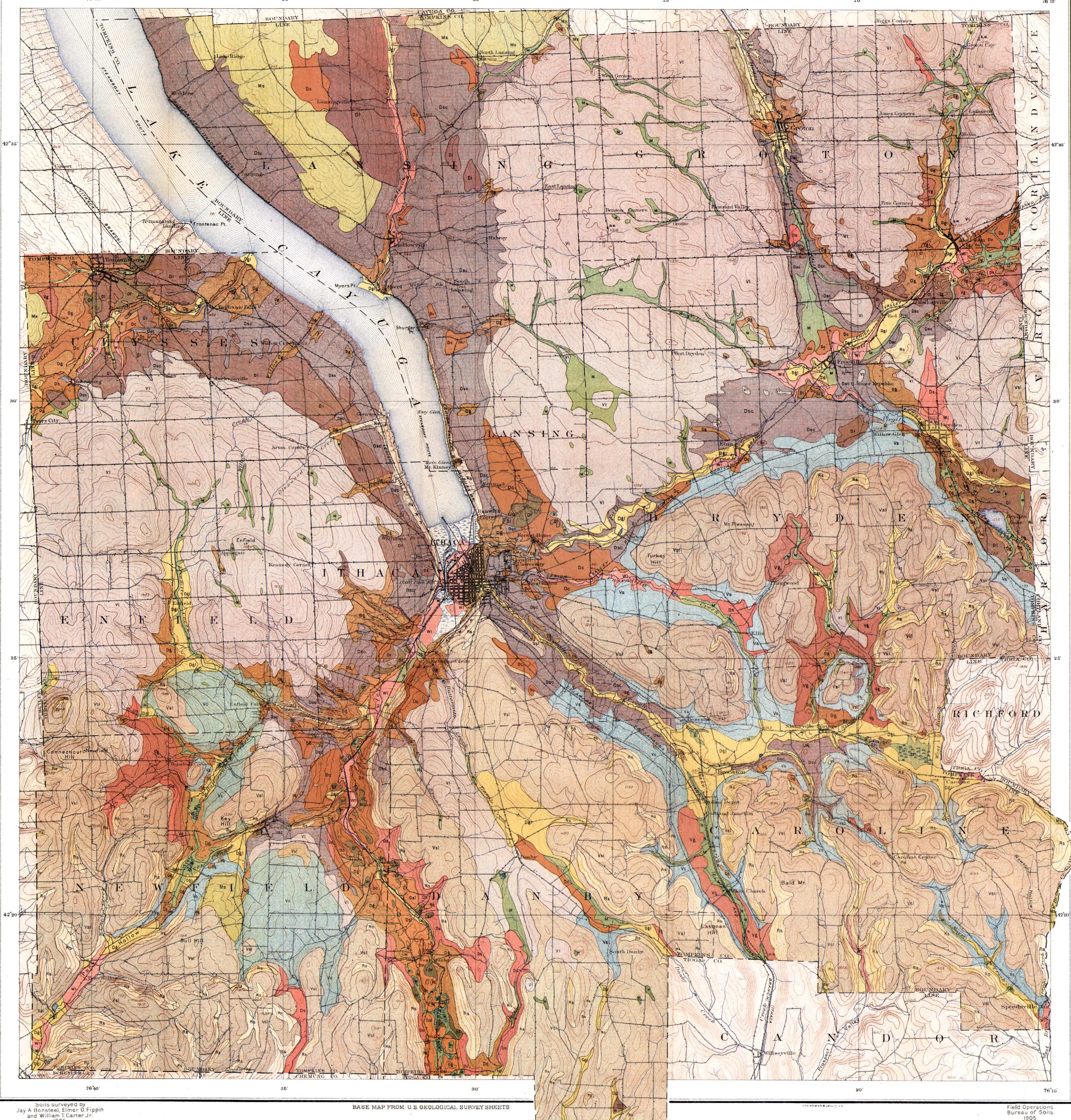
Stony loam

Shale loam

Silt loam

Silty loam

Clay



BASE MAP FROM U.S. GEOLOGICAL SURVEY SHEETS

Scale 1:250,000
Contour interval 20 feet
1 mile
2 miles
3 miles
4 miles
kilometers

Field Operations
Bureau of Soils
1905

Soils surveyed by
Jay A Bonsteel, Elmer O Fippin
and William T Carter Jr.
1905